

Using Entity Matching to enrich wiki content

Semi-automatic enrichment of a semantic virtual research environment with external data. Development of a solution in form of a SMW Plugin.

INSTITUTE OF APPLIED INFORMATICS AND FORMAL DESCRIPTION METHODS (AIFB), FACULTY OF ECONOMICS AND BUSINESS ENGINEERING, DEPARTMENT OF INFORMATICS



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Karlsruhe Institute of Technology (KIT)

Overview

1. Introduction
 1. Problem definition
 2. Objectives
2. Solution architecture
3. Implementation
4. Evaluation

Introduction

- Background
 - Science becoming more global
 - Collaboration of institutes, across different cities, countries
 - More interconnections at the same time through global collaboration

Wilsdon, James. *Knowledge, networks and nations: global scientific collaboration in the 21st century*. The Royal Society, 2011.

Introduction

- Virtual Research Environment (VRE)
 - Definition: „A VRE is best viewed as a framework into which tools, services and resources can be plugged.“ M. Fraser. *Virtual research environments: overview and activity*. Ariadne, 44:31–40, 2005.
 - Definition: „Virtual Research Environments are innovative, web-based, community-oriented, comprehensive, flexible, and secure working environments conceived to serve the needs of modern science.“ Candela, Leonardo, Donatella Castelli, and Pasquale Pagano. *Virtual Research Environments: An Overview and a Research Agenda*. Data Science Journal 12.0 (2013): GRDI75-GRDI81.
 - Synonyms:
 - Virtual Research Environments* (Carusi & Reimer, 2010)
 - Science Gateways* (Wilkins-Diehr, 2007)
 - Collaboratories* (Wulf, 1993)
 - Digital Libraries* (Candela, Castelli, & Pagano, 2011)
 - Inhabited Information Spaces* (Snowdon, Churchill, & Frécon, 2004)
- L. Candela. *Virtual Research Environments*, GRDI2020, <http://www.grdi2020.eu/Repository/FileScaricati/eb0e8fea-c496-45b7-a0c5-831b90fe0045.pdf>, Date: 06.04.2014
- Provides the means to work on research questions collaboratively
 - Overcoming e.g. locational or temporal barriers

Introduction

- Virtual Research Environment (VRE)
 - <https://nanoHUB.org/> „Online simulation and more for nanotechnology“

Resources: Tools

Browse by Tags
Browse Visually

Tag	Resources	Sort by Title	Info
[All]	> BJT Lab	>	MOSFet
NCN Supported (44)	> Carrier Statistics Lab	>	Simulates the current-voltage characteristics for bulk, SOI, and double-gate Field Effect Transistors (FETs)
1D (1)	> Crystal Viewer Tool	>	Learn more
1D conduction (1)	> Drift-Diffusion Lab	>	Launch Tool
2D (3)	> MOSCap	>	
2D solidification undercooled anisotropy (2)	> MOSFet	>	
2D Spinodal Decomposition (1)	> Periodic Potential Lab	>	
3D atom probe (1)	> Piece-Wise Constant Potential Barriers ...	>	
3D Spinodal Decomposition (1)	> PN Junction Lab	>	
4-level system (1)	>		
AAE590D (2)	>		
ab initio (8)	>		
ABACUS (9)	>		
absorption spectra (1)	>		
actuators (2)	>		

Show: ☒ K-12 ☒ Easy ☒ Intermediate ☒ Advanced ☒ Expert What is this? About audience levels

7.6 RANKING
 NCN Supported
4669 users, detailed usage
1267 users in 121 classes
6 Citation(s)
14 questions (Ask a question)
4 review(s) (Review this)
1 wish(es) (Add a new wish)

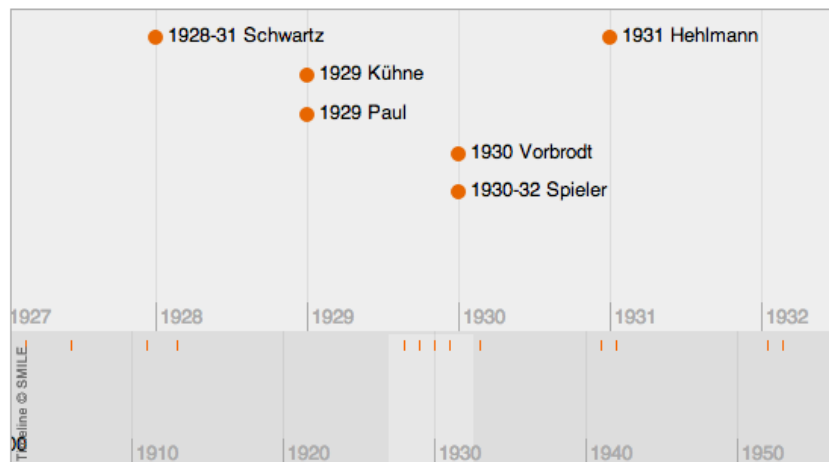
Introduction

- Virtual Research Environment (VRE)

- <http://smw-cora.org/>  **Semantic CorA**
Semantic Collaborative Corpora Analysis for Humanities and Social Sciences

„Semantic collaborative Corpora Analysis for Humanities and Social Sciences“

Interactive Timeline of Integrated Lexica



Enhancing Research Processes (Research Tools)

- **Integrate Data:** Tools to integrate data, which is not yet digitized.
- **Browse & Annotate:** At the moment you will find there a list of all lexicon.
- **Analyse & Request:** Links to the Analysis-Tool, which allows to ask complex queries.
- **Metadata Gardening:** It's time to tidy up.
- **Proof & Account:** Evaluating data.
- **Refer & Index:** Text, text, text, and text.
- **Export:** You can export data in rdf., csv, bibtex. etc

Developed by:



DIPF

Educational Research
and Educational Information



GEORG-AUGUST-UNIVERSITÄT
GÖTTINGEN

Funded by:



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Problem definition

- Example: two Datasets taken from Semantic CorA Date: 17.02.2014
 - Different amounts of attributes



Semantic CorA

Semantic Collaborative Corpora Analysis for Humanities and Social Sciences

Villaume, Peter

Lebensdaten

[Bearbeiten]

Geburtsdatum:	16.07.1746
Sterbedatum:	10.06.1825
Geburtsort:	Berlin
Geschlecht:	männlich
Nationalitäten:	deutsch
Berufe:	LehrerIn, AnstaltsleiterIn, SchriftstellerIn
Wirkungstätten:	Berlin, Halberstadt, Fyrendal
Schulenzugehörigkeiten:	Philanthropen
Wirkungsgebiete:	Theorie, Praxis

Dransfeld, Hedwig

Lebensdaten

[Bearbeiten]

Geburtsdatum:	24.11.1871
Sterbedatum:	13.03.1925
Geschlecht:	weiblich

- New research question arises: occupation now in focus
- Problem: Occupation attribute set only on 375 of 4014 persons

Problem definition

- 1) Identification of corresponding entities in external data sources
- Example: Deutsche Nationalbibliothek (German National Library)



Semantic CorA

Semantic Collaborative Corpora Analysis for Humanities and Social Sciences

Dransfeld, Hedwig

Lebensdaten [\[Bearbeiten\]](#)

Geburtsdatum:	24.11.1871
Sterbedatum:	13.03.1925
Geschlecht:	weiblich



Gesamter Bestand
Musikarchiv
Exilsammlungen
Buchmuseum

→ Suchformular zurücksetzen

→
☐ Expertensuche [?](#)

Tragen in sozialer Verantwortung
Schmücker, Else. - Paderborn : Schöningh, [1963]

4 Hedwig Dransfeld
Richartz, Maria. - Meitingen bei Augsburg : Kyrios-Verl., 1949

5 Buch der Wünsche
Dransfeld, Hedwig. - Hamm (Westf.) : R. W. Thiemann, [1930]

6 Der gute Ton für die heranwachsende Jugend
Dransfeld, Hedwig. - Hamm (Westf.) : R. W. Thiemann, [1930]

7 Weihnachtsfeier in Schule und Haus
Dransfeld, Hedwig. - Hamm (Westf.) : R. W. Thiemann, [1930], 4. Aufl.

Die Sprachwörter

Problem definition

- 1) Identification of corresponding entities in external data sources
- Example: Deutsche Nationalbibliothek (German National Library)



Semantic CorA

Semantic Collaborative Corpora Analysis for Humanities and Social Sciences

Dransfeld, Hedwig

Lebensdaten [\[Bearbeiten\]](#)

Geburtsdatum:	24.11.1871
Sterbedatum:	13.03.1925
Geschlecht:	weiblich



GND	
Link zu diesem Datensatz	http://d-nb.info/gnd/119206366
Person	Dransfeld, Hedwig
Geschlecht	weiblich
Quelle	LCAuth B 2006 (online) Westfälische Lebensbilder. Bd. 12. 1979 (S. 145)
Zeit	Lebensdaten: 1871-1925
Land	Deutschland (XA-DE)
Geografischer Bezug	Geburtsort: Hacheney Sterbeort: Werl

Problem definition

2) Data integration

- Example: Occupation



Semantic CorA

Semantic Collaborative Corpora Analysis for Humanities and Social Sciences

Dransfeld, Hedwig

Lebensdaten [\[Bearbeiten\]](#)

Geburtsdatum:	24.11.1871
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Land	Deutschland (XA-DE)
Geografischer Bezug	Geburtsort: Hacheney Sterbeort: Werl
Beruf(e)	Politikerin Pädagogin Schriftstellerin Feministin
Weitere Angaben	Dt.Politikerin, Vorsitzende des 'Katholischen Deutschen Frauenbundes', Schriftstellerin u. Pädagogin
Beziehungen zu Organisationen	Katholischer Deutscher Frauenbund (seit 1912 Vorsitzende) Deutsches Reich / Reichstag (Abgeordnete)
Systematik	6.4p Personen zu Bildungswesen ; 9.5p Personen zu Soziologie, Gesellschaft, Arbeit, Sozialgeschichte ; 12.2p Personen zu Literaturgeschichte (Schriftsteller)
Typ	Person (piz)
Autor von	30 Publikationen 1. <i>Buch der Wünsche</i> Dransfeld, Hedwig. - Hamm (Westf.) : R. W. Thiemann, [1930] 2. <i>Der gute Ton für die heranwachsende Jugend</i> Dransfeld, Hedwig. - Hamm (Westf.) : R. W. Thiemann, [1930]

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Objectives

- Formulation of objectives

Development of a solution to the presented problems for a Virtual Research Environment. Important aspects:

- 1) Semi-automatic identification of corresponding entities
- 2) Semi-automatic integration of data from identified entities
- 3) Usability to support researchers in regard to 1) and 2)

- Note to 3) Usability

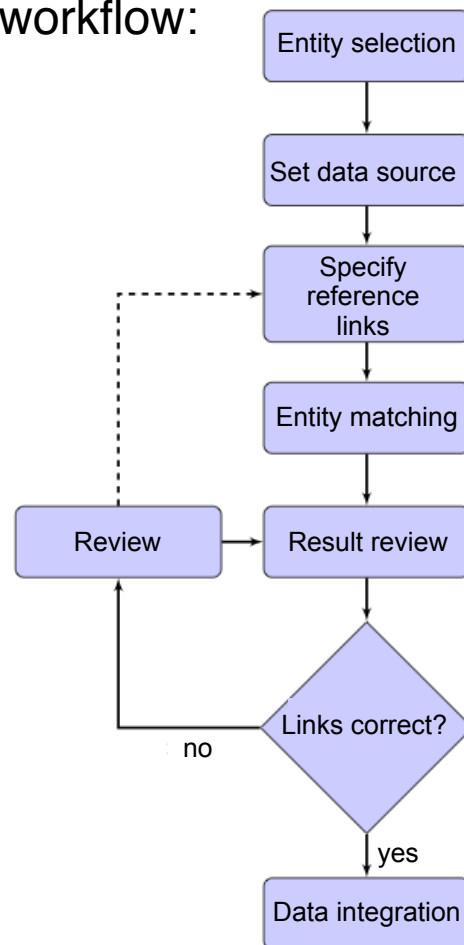
- Implication: Need to support expressing new matching strategies
- Implication: Need to support data integration process

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Solution architecture

1. Identification of various requirements
2. Define basic workflow:



Solution architecture

1. Identification of various requirements
2. Define basic workflow
3. Chose basic architecture alternative in regard to Entity Matching software.
Assessment of the degree of software reuse, scalability, maintainability and development effort.

Primary architecture options:

- A1 Stand-alone execution
- A2 Reuse existing implementations
- A3 Webservice
- A4 Own implementation

Solution architecture

1. Identification of various requirements
2. Define basic workflow
3. Chose basic architecture alternative in regard to Entity Matching software.
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Primary architecture options:

A1 Stand-alone execution ✓

A2 Reuse existing implementations

A3 Webservice

A4 Own implementation

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Implementation

- Selection of Entity Matching frameworks

- Identification of 33 Entity Matching frameworks

Swoosh, SERF, Silk - Linking Framework, LIMES, ReIDC Engine, AgreementMakerLight, CIDER-CL, CroMatcher, IAMA, LogMap, LogMapLt, MaasMatch, StringsAuto MapSSS, ODGOMS, RiMOM, ServOMap, SLINT+, SPHeRe (System for Parallel Heterogeneity Resolution), SYNTHESIS, WeSeE-Match, XmapGen, XmapSiG, YAM++, ...

- Selection of suitable frameworks, based on...

- Availability
 - Features
 - Integrability
 - Development/maintenance status

- Candidates: LIMES (completed), Silk (prepared)

- Abstraction over Entity Matching frameworks

- Improves software evolution
 - Opportunity to combine different Entity Matching approaches, to improve results and lower context dependence [CKM09]

Implementation

- Methods of Data integration
 - Semantic Web Browser (SWB) for review and correction, as well as displaying external data in local entities
 - Parser function to query **job information** und **results**

Vorlage

Diskussion

Lesen

Bearbeiten
Versionsgeschichte

Suchen

Vorlage:MatchingResult

ID 1072633873
Name Some job
Beschreibung With a description
Entitäten 1758145034
Referenzlinks 811888964
Datenquelle 452816685
Fortschritt
Angefangen Tue, 10 Jun 2014 15:25:08 +0200
Abgeschlossen Fri, 06 Jun 2014 16:24:17 +0200

local entity	similarity	external entity
http://testwiki.smw-cora.org/index.php/Spezial:URI-Auf%C3%B6ser/Spieler,_Josef	0.98	http://d-nb.info/gnd/17050199X
http://testwiki.smw-cora.org/index.php/Spezial:URI-Auf%C3%B6ser/Spieler,_Josef	0.98	http://d-nb.info/gnd/117483885

Implementation

- Front-end implementation
 - GUI structured in sections
 - Job management, entity selection, data sources, reference links, result review and correction
 - Working in different sections independently is possible

Spezialseite

SMWEnrich

Current Jobs
Entity Selection
Data Source
Reference Links
Review

Which job do you want to modify?

☒
Some job With a description ✖ start Working...

☐
<new job name> <new job description> ✖ start Working...

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Evaluation

- Formative and summative evaluation
- Theoretical review
 - Achievement of objectives
 - Requirements covering
- Assessment of usability
 - Usability test
 - Questionnaire ISONORM 9241/110 [JP97] (long version)

Evaluation

- Achievement of objectives

Development of a solution for a virtual research environment. Essential aspects:

- 1) Semi-automatic identification of corresponding entities
- 2) Semi-automatic integration of data from identified entities
- 3) Usability to support researchers in regard to 1) und 2)

- Generic solution as MediaWiki / SMW extension for all virtual research environments, based on MediaWiki / SMW.
- Solution covers aspect 1) completely.
- Solution covers aspect 2) partially: Concept takes semi-automatic data integration into account, though implementation in prototype not yet completed.
- Solution covers aspect 3) for the most part.
Results of a usability evaluation on following slides.

Evaluation

- Usability test
 - *Co-Discovery* method in combination with the *Coaching Method* [SB11].
 - Subjects should work through the main success scenario from use case 1 (identification of external entities) together and communicate their thoughts in the process
 - Asking questions was allowed, but help on tasks was only given, if the subjects were not able to solve a task at all.
 - Problems were discovered by observation and feedback.
 - 2 Subjects: Researchers who were familiar with Semantic CorA.
 - “Real” data taken from Semantic CorA.
 - Overall result:

With only little help the subjects were able to complete all steps of the main success scenario of use case 1 and thereby achieve the goal of this use case.

Evaluation

- Usability test
 - Usability problems
 - Unintuitive adding of elements
 - Missing descriptions or explanations
 - No options for working on multiple elements simultaneously
 - Confusing layout

Evaluation

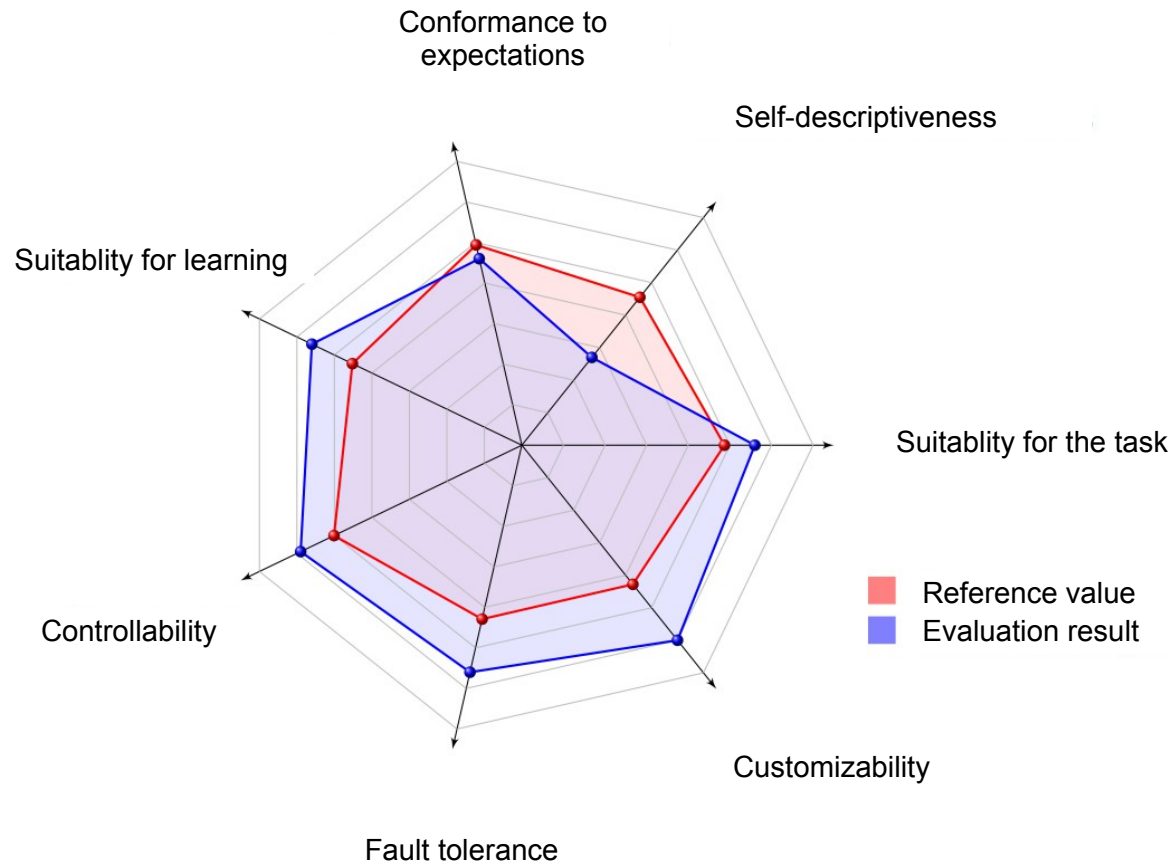
- ISONORM 9241/110 (long version) [JP97]
 - Standardized questionnaire, concerning the series of standards *Ergonomie der Mensch-System-Interaktion*, Section 110 of DIN EN ISO 9241 (German Institute for Standardization).
 - 35 Questions which are answered by 7-step gamut ranging from *very negative* to *very positive*.
 - Suitable for summative as well as formative evaluation.
 - Comparability with other software.
 - No special training for subjects required.

Evaluation

- Open problems
 - Functionality of data integration
 - Semantic Web Browser integration not yet completed
 - Prototype does not allow to create mappings from data to an internal vocabulary of the virtual research environment
 - Further integration of Entity Matching frameworks
 - LIMES Entity Matching framework integrated
 - Silk framework selected but not yet implemented in the prototype
 - Extension of configuration options
 - Many technical details hidden from users
 - Evaluation for default values needed
 - Provenance and access control
 - No rights management, access control or provenance information apart from default SMW/MediaWiki functionality

Evaluation

- ISONORM 9241/110 (long version) [JP97]
 - Result

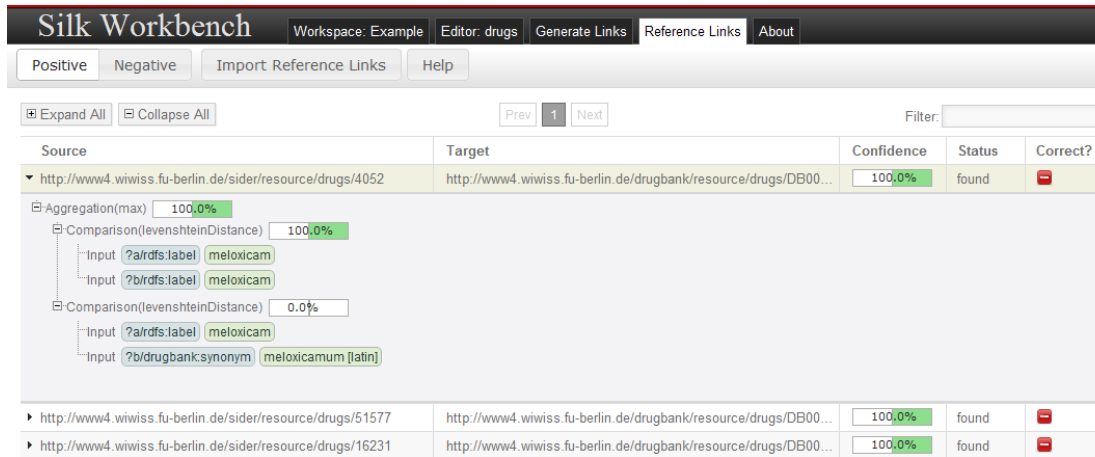


Evaluation

- Opportunities for improvement / outlook
 - Investigation on other implementation options (slide 17)
 - A2 Reuse of existing implementations
 - A3 Webservice
 - A4 Own implementation

Evaluation

- Opportunities for improvement / outlook
 - Automatic selection of candidates for reference links (e.g. by approaches such as Silk [VBGK09] or SAIM [LHS+13])



Silk Workbench Workspace: Example Editor: drugs Generate Links Reference Links About

Positive Negative Import Reference Links Help

Expand All Collapse All Prev 1 Next Filter:

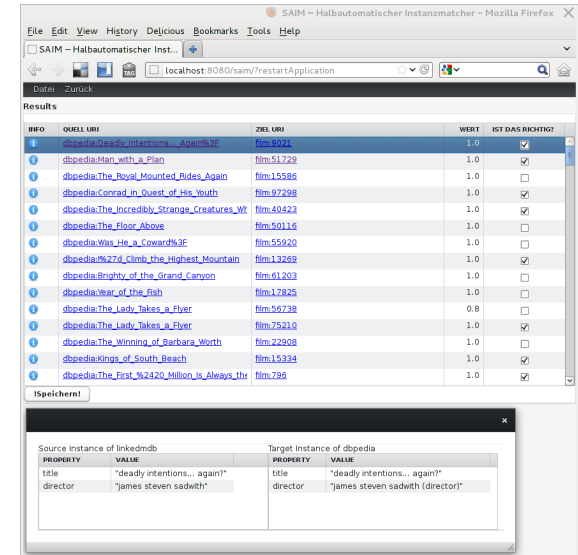
Source	Target	Confidence	Status	Correct?
http://www4.wiwiss.fu-berlin.de/sider/resource/drugs/4052	http://www4.wiwiss.fu-berlin.de/drugbank/resource/drugs/DB00...	100,0%	found	

Aggregation(max) 100,0%

- Comparison(levenshteinDistance) 100,0%
 - Input ?a/rdfs:label meloxicam
 - Input ?b/rdfs:label meloxicam
- Comparison(levenshteinDistance) 0,0%
 - Input ?a/rdfs:label meloxicam
 - Input ?b/drugbank:synonym meloxicamum [latin]

Source	Target	Confidence	Status	Correct?
http://www4.wiwiss.fu-berlin.de/sider/resource/drugs/51577	http://www4.wiwiss.fu-berlin.de/drugbank/resource/drugs/DB00...	100,0%	found	
http://www4.wiwiss.fu-berlin.de/sider/resource/drugs/16231	http://www4.wiwiss.fu-berlin.de/drugbank/resource/drugs/DB00...	100,0%	found	

Quelle: Silk Link Discovery Framework Wiki
https://www.assembla.com/wiki/show/silk/Managing_Reference_Links



SAIM – Halbautomatischer Instanzmatcher – Mozilla Firefox

File Edit View History Delicious Bookmarks Tools Help

SAIM – Halbautomatischer Instanzmatcher

localhost:8080/saim/restartApplication

Results

ID	URI	WERT	IST DAS RICHTIG?
1	dbpedia:Deadly_Intentions..._Again?F	1,0	
2	dbpedia:Man_with_a_Plan	1,0	
3	dbpedia:The_Royal_Mounted_Rides_Again	1,0	
4	dbpedia:Conrad_in_Quest_of_His_Youth	1,0	
5	dbpedia:The_Incredibly_Strange_Creatures_W	1,0	
6	dbpedia:The_Floor_Above	1,0	
7	dbpedia:Was_He_a_Coward?E	1,0	
8	dbpedia:274_Climb_the_Highest_Mountain	1,0	
9	dbpedia:Brigby_of_the_Grand_Canyon	1,0	
10	dbpedia:Year_of_the_Fish	1,0	
11	dbpedia:The_Lady_Takes_a_Flyer	0,8	
12	dbpedia:The_Lady_Takes_a_Flyer	1,0	
13	dbpedia:The_Winning_of_Barbara_Worth	1,0	
14	dbpedia:Kings_of_South_Beach	1,0	
15	dbpedia:The_First_2420_Million_is_Always_The	1,0	

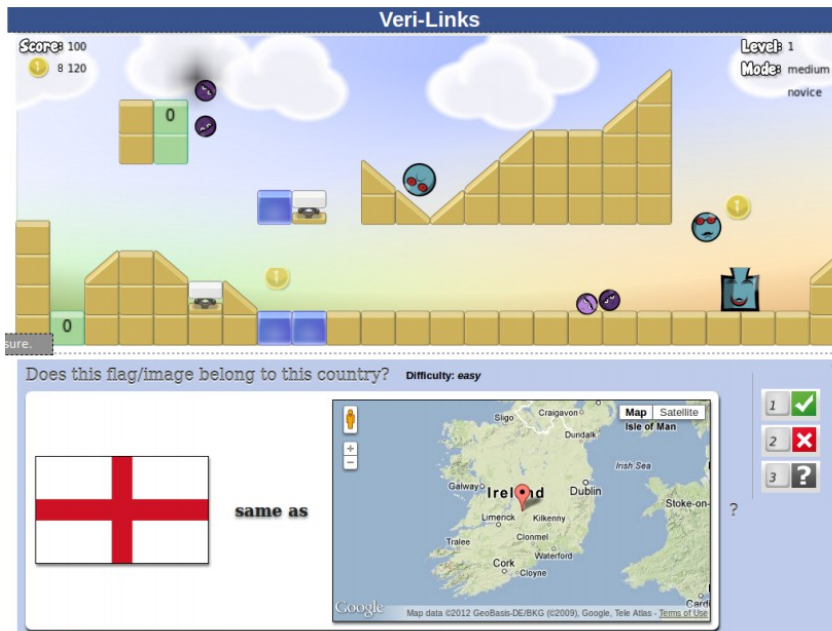
!Speichern!

PROPERTY	VALUE	PROPERTY	VALUE
title	"deadly intentions... again?"	title	"deadly intentions... again?"
director	"james steven sadwith"	director	"james steven sadwith (director)"

Quelle: SAIM Projekt Seite
<http://aksw.org/Projects/SAIM.html>

Evaluation

- Opportunities for improvement / outlook
 - Entity Matching by crowdsourcing



Game with a purpose (GWAP): *Veri-Links*, [LNE13]

Interesting within the context of virtual research environments or wikis as some of these have large user groups and therefore have a great potential for utilizing crowdsourcing.

Thank you for your attention!

Appendix

- Use Case 1, notation by [ACB03]

VREU – Virtual Research Environment User

Primary Actor: VREU

Level: User goal

Precondition: The Virtual Research Environment contains at least one entity.

Postcondition: The amount of entities in the Virtual Research Environment has not changed.

Main success scenario:

1. VREU selects entities which are to be identified in external data sources.
2. VREU sets the storage location of the external data source (SPARQL Endpoint or RDF File in local file system).
3. VREU provides some reference-links for the Entity Matching system.
4. VREU reviews links generated by the Entity Matching system.

Appendix

- Use Case 1 (continuation)

Extensions:

2a. External data not accessible (unable to read input file or SPARQL endpoint unavailable).

2a1. Error is shown to the VREU.

2a2. VREU cancels this use case or restarts.

Variations:

3'. Reference-links are proposed by the Entity Matching system and only have to be accepted or denied by the VREU.

4'. Links are integrated into the Virtual Research Environment without review.

4''. Links are only reviewed on selected entities.

4''''. No links were found.

Appendix

- Use Case 2

VREU – Virtual Research Environment User

Primary Actor: VREU

Level: User goal

Includes: Use Case 1

Precondition: At least 1 link was generated in Use Case 1.

Invariant: The amount of entities does not change.

Postcondition: Selected entities were enriched with external data.

Main success scenario:

1. VREU specifies a mapping from the vocabulary of the external dataset to the vocabulary of the Virtual Research Environment.
2. VREU selects data types which are to be integrated.

Appendix

- Use Case 2 (continuation)

Extensions: 2a. VREU defines rules, how data should be modified upon import (e.g. by automatic translation).

Variations: 1a. Mapping on the identity, to adopt attributes without change.

Appendix

- Related Work
 - Becker, Christian, Bizer, Christian, Erdmann, Michael and Greaves, Mark.
Extending SMW+ with a Linked Data Integration Framework. Paper presented at the meeting of the Posters & Demos at the International Semantic Web Conference (ISWC2010), Shanghai, 2010.
 - Architecture: (experpt)
 - Web Data Access Module (LDSpider, SPARQL, RDF dumps)
 - Vocabulary Mapping Module (R2R Framework)
 - Identity Resolution Module (LDIF, Silk Server)
 - Quality Evaluation Module (Trust Policy Evaluation Engine)
 - Integrated Web Data (Named Graph Data model and provenance information)
 - Front-End:
 - Ontology Browser of SMW+
 - Inline queries and interactive query interface

Appendix

- Related Work
 - Becker, Christian, Bizer, Christian, Erdmann, Michael and Greaves, Mark.
Extending SMW+ with a Linked Data Integration Framework. Paper presented at the meeting of the Posters & Demos at the International Semantic Web Conference (ISWC2010), Shanghai, 2010.
- Differences to this work (selection)
 - Specific domain: Genes \leftrightarrow domain independence
 - Restricting matching to specific entities
 - Supporting the user upon matching in new domains
 - Different workflows when matching

Appendix

- Implemented standards
 - XML
 - Server ↔ client communication
 - Ontology Alignment Format
 - Specification of reference-links
 - Output of results
 - RDF with serializations RDF/XML, N-Triples, Turtle, OWL, N-Quads
 - Input format of datasets

Appendix

- ISONORM 9241/110 (long version) evaluation results

	Result	Reference value
Conformance to the task	5.6	4.87
Self-descriptiveness	2.7	4.55
Conformance to expectations	4.6	4.94
Suitability for learning	5.6	4.52
Controllability	5.9	5.01
Fault-tolerance	5.6	4.29

Appendix

- GUI – Entity Selection

Spezialseite

SMWEnrich

Current Jobs
Entity Selection
Data Source
Reference Links
Review

Which entity list do you want to use?

☒ New selection Description ✖

☐ New selection Description ✖

- Spieler, Josef ✖
- Dransfeld, Hedwig ✖

Add entity:

Add category:

ASK query:

Appendix

- GUI – Data Sources

Spezialseite

SMWEnrich

Current Jobs
Entity Selection
Data Source
Reference Links
Review

Which external data source do you want to use?

☐ dnb ✖

☒ dnb rdf file ✖

Add new data source:

Appendix

- GUI – Reference Links

Spezialseite

SMWEnrich

Current Jobs

Entity Selection

Data Source

Reference Links

Review

Select reference links group

☒ Some Name With a description ✖

☐ New link group Description ✖

☒ Spieler, Josef <http://d-nb.info/gnd/117483885> ✖

Add reference link:

Appendix

- GUI – Ergebnisse

Spezialseite

SMWEnrich

Current Jobs	Entity Selection	Data Source	Reference Links	Review
--------------	------------------	-------------	-----------------	--------

Are these links correct?

http://localhost/smw-cora/index.php/Spezial:URI-Auf%C3%B6ser/Spieler_Josef ← 0.98 → http://d-nb.info/gnd/117483885 ✗
http://localhost/smw-cora/index.php/Spezial:URI-Auf%C3%B6ser/Spieler_Josef ← 0.98 → http://d-nb.info/gnd/17050199X ✗

Sources

- [HB11] Heath, Tom und Christian Bizer: *Linked data: Evolving the web into a global data space*. Synthesis lectures on the semantic web: theory and technology, 1(1):1–136, 2011.
- [Mar03] Martin, Robert Cecil: *Agile Software Development: Principles, Patterns, and Practices*. Prentice Hall PTR, Upper Saddle River, NJ, USA, 2003.
- [CMK09] Chen, Zhaoqi, Dmitri V. Kalashnikov und Sharad Mehrotra: *Exploiting context analysis for combining multiple entity resolution systems*. In: Proceedings of the 2009 ACM SIGMOD International Conference on Management of data, Seiten 207–218. ACM, 2009.
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